Geophysical Research Abstracts,
Vol. 11, EGU2009-4178-2, 2009
EGU General Assembly 2009

Superdiffusion at outer magnetospheric boundaries

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Multipoint measurements in the magnetosheath (MSH) provide an opportunity to investigate the processes that might lead to enhanced transport in a strongly disturbed plasma under collisionless conditions. The respective non- adiabatic transport can be much faster than conventional diffusion. On the basis of Cluster, Interball, Double Star and Geotail observations in the MSH we provide evidence for the temporary existence of superdiffusion as well in the region close to the bow shock (BS) as near the magnetopause (MP). Disturbed zones of duration of more than one hour are regularly detected in the MSH, preferably downstream of the oblique BS. These zones are similar to high-latitude MSH near the MP, known as the 'turbulent boundary layer', which is the result of the interaction of the MSH flow with the throat of the cusp. In these extremely disturbed zones magnetic field and plasma fluctuations have comparable intensity and similar spectral and statistical properties. Both field and plasma fluctuations demonstrate intermittency and a multifractal statistics. The higher order structure functions are analyzed to characterize the self-similarity and intermittency. The structure function scalings are nonlinear and deviate strongly from the Kolmogorov's K41 model prediction. The scalings are similar for magnetic field and ion flux. The nonlinear scaling is interpreted in a frame of the log-Poisson model of intermittent turbulence. Resonant Alfvenic perturbations at few mHz are amplified and standing at the MP with 4- wave features in tri-coherence spectra. We find that about 20% of the intense ram pressure bursts which are known as 'plasma jets' and provide the anomalous transport, should erode the high- latitude MP. They provide the flank magnetosphere with a superdiffusive population. These intermittent or transient jets have ram pressure several times that of the solar wind (SW). Since in the jets the dynamic pressure does not decrease but rises instead, this contradicts the MHD predictions for a local transformation of SW kinetic energy into thermal energy at the BS. We discuss possible non- local dynamical energy re- distribution in the MSH. Obviously the jets serve to dissipate the kinetic energy in the boundary layers in an effective way. This seems to be typical for collisionless boundary layers in the astrophysical plasma as well as and in laboratory plasmas.
This work was supported by ISSI and INTAS- 05-1000008-8050 grant.